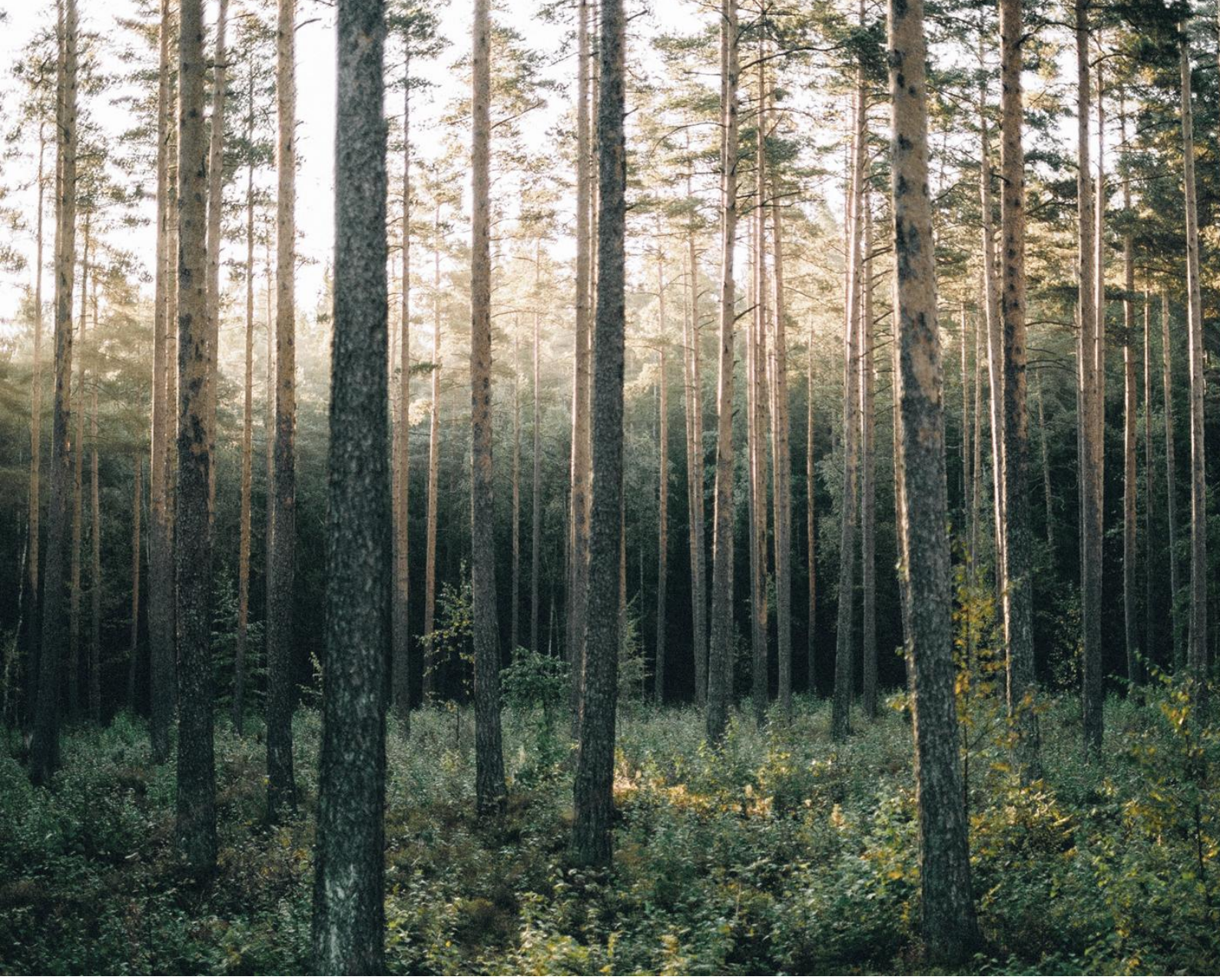

Options for Decarbonisation of the existing SEM CRM Design

A report to the SEM Committee

DECEMBER 2025

AFRY

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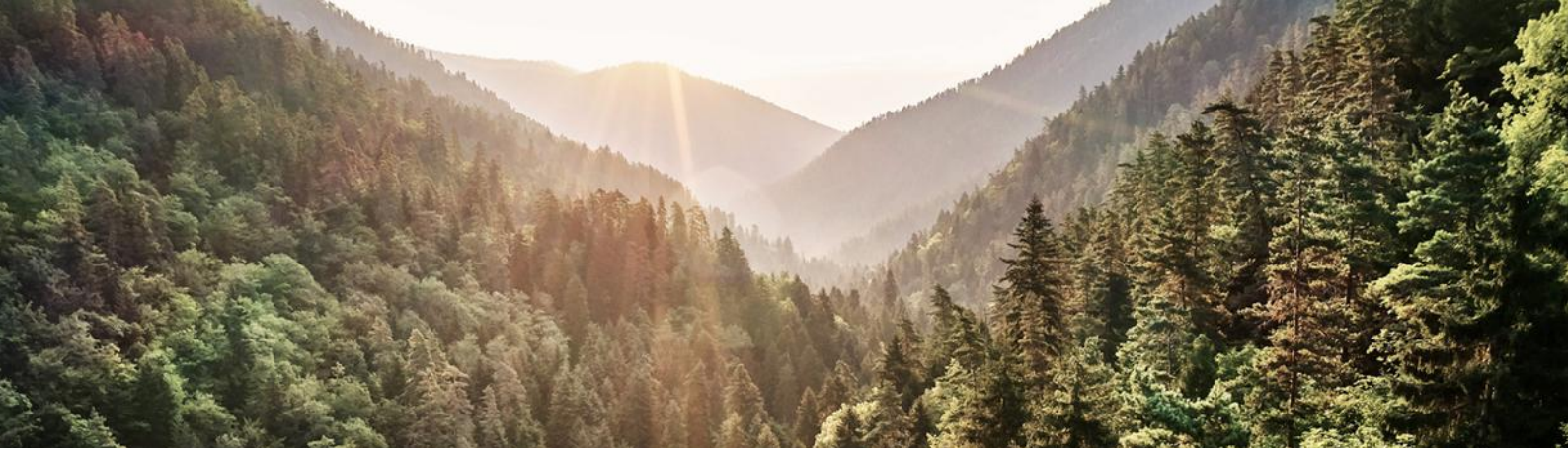


1 Executive Summary

AFRY has been engaged by the Regulatory Authorities (RAs) on behalf of the SEM Committee (SEMC) to support development of the SEM Capacity Market in two phases.

The first of these phases commences with an assessment of options for decarbonisation of the existing CRM, for which State aid approval is due to expire in May 2028. The assumption for the purpose of this work is that any measures implemented pursuant to this assessment would be put in place for the next T-4 capacity auction after the upcoming 2029/30 T-4 in March 2026.

This report sets out our assessment of options for decarbonisation of the existing CRM in the SEM and a recommended path forward for SEMC. It follows on from SEMC's decision in relation to Intermediate Length Contracts (ILCs) and their commitment to further examine options for decarbonisation at that time. It is also driven by the Climate, Energy and Environmental Aid State Aid Guidelines (CEEAG), introduced since the original State aid approval for the existing CRM. The CEEAG guidelines place a greater emphasis on decarbonisation than the previous guidelines.

As context, the second phase of this programme of work will relate to the new Capacity Market design to be implemented following expiry of the current State aid approval.

Our work on Phase 1, detailed in this report, is bounded by the following constraints:

- decarbonisation measures must be implementable in time for the next T-4 auction after the upcoming 2029/30 T-4 in March 2026;
- two to three T-4 auctions are expected to take place between that T-4 and the expiry of the State aid approval for the existing design; and
- decarbonisation measures are therefore expected to begin taking effect in the years 2030-33.

Given the relatively limited time frame that we are targeting in our assessment of options for decarbonisation, we have examined the "Decarbonisation Potential" associated with the auctions to be held within the remaining lifetime of the existing CRM design. Our assessment shows that the capacity that does not yet have a contract for the target years 2030-33 accounts for lower emissions over the period 2030 to 2050 than the capacity that is already contracted. Despite this however, emissions associated with uncontracted capacity are nonetheless significant, and it is these emissions

that represent the outer envelope of the Decarbonisation Potential of the existing CRM i.e. these are the emissions that decarbonisation measures can aim to mitigate. A further key finding of this analysis is that the bulk of the emissions coming from uncontracted capacity are associated with existing capacity that is already on the system at this time, rather than new capacity.

We have examined approaches to decarbonisation in other European Capacity Markets – specifically GB, Poland, Belgium, Italy and France. GB, Poland and Belgium have all taken steps to facilitate decarbonisation, including:

1. different variations on the Intermediate Length Contracts (ILCs) that were recently introduced in SEM;
2. a requirement for a decarbonisation commitment from contracted parties;
3. tightening of the CO_2 threshold for eligibility; and
4. additional contract length for any capacity that meets a certain emissions threshold requirement.

We have also carried out a broader scan of decarbonisation measures, including those proposed by industry in response to the ILCs consultation, those previously considered by SEMC, and those given as examples in the CEEAG guidelines. By combining these options with our in-house market design expertise, we have produced a long list of options, some representing substantial change and others minimal change. We have then screened this list to remove options that are:

- not deemed to be compliant with the CEEAG guidelines;
- not implementable within the defined timeframe; and/or
- being considered or progressed elsewhere by the Regulatory Authorities.

We have consolidated the remaining options, including through the application of the following key principles:

- An obligation on contracted parties to decarbonise is not appropriate at this time. Given the timeframe that is relevant for this work, we believe that it is not appropriate, or likely to be effective, to introduce measures that are intended to *obligate* decarbonisation. This is because of the uncertainty around the deployment of the range of low carbon technologies for power generation in SEM within this timeframe.
- Derating factors (DRFs) should not be amended to reflect carbon intensity. We believe that DRFs should not be used to incentivise, or disincentivise, technology types based on their carbon emissions intensity. DRFs are intended to capture the adequacy contribution of each technology that participates in the CRM.

The design of the consolidated options has been developed and each option evaluated against the following criteria:

- decarbonisation impact;
- deliverability; and
- alignment with the objectives of the existing CRM design.

On the basis of this evaluation, we believe that there are two alternative principal measures that SEMC can consider implementing to support decarbonisation of the CRM, bearing in mind the contribution of uncontracted new capacity and existing capacity to the overall emissions associated with the CRM out to 2050.

The first of these measures is a "Green Bonus", similar to that in place in Poland. This would create an incentive for existing and new capacity to reach a specified (reduced) emissions threshold in return for an additional contract duration of one year. The appropriate threshold should be determined in consultation with industry. A requirement for gas units availing of the Green Bonus to be hydrogen-blend ready could also be implemented.

The second is the "Green Scalar", which would represent a more nuanced approach to the incentivisation of lower Carbon technology in the SEM CRM, allowing a greater degree of parameterisation and fine-tuning. This does not have a precedent that we are aware of in Europe, and as such carries greater risk in terms of development, implementation and State aid approval.

We expect that either measure would require State aid approval and we recommend early and regular engagement with the State aid authorities in both jurisdictions to ensure that the approval process is a smooth one (and to lay the ground for the State aid application for the new Capacity Market design in Phase 2).

Following on from the recent introduction of 5-year ILCs in the SEM, and taking into consideration the existence of alternative durations of ILC in other markets, we have evaluated the possibility of a shorter length ILC, but have concluded that this would add little to the investment incentives available to existing capacity through the standalone Unit-Specific Price Cap process, and the 5-year ILC option already in place.

In addition, there are two "softer" supporting measures that SEMC can consider implementing to support decarbonisation of the CRM.

Firstly, in the context of the existing requirements for monitoring and verification of CO_2 emissions from Capacity Market Units, an additional requirement could be introduced for this emissions data to be published on a regular basis in order to bring greater transparency, and to inform future decarbonisation policy development.

Secondly, a Decarbonisation Commitment from multi-year capacity market units could be introduced, requiring these participants to actively plan for decarbonisation of their capacity, and to acknowledge their responsibility for supporting the achievement of net zero targets.

Alongside these two alternative principal measures, and two supporting measures, we highlight the importance of using the mechanism for capacity cost recovery from customers to drive implicit demand response in a way

that reduces the need to procure new capacity to ensure security of supply. We recognise however that targeted cost recovery can only have limited effect unless the technology and processes are in place to allow consumers to react to a variable charge, and that the effective and full implementation of this measure extends beyond the rules of the Capacity Market into the retail and smart metering space.

The key messages contained in this report are summarised in Exhibit 1.

Exhibit 1: Overview of key messages contained in this report.

Timeframe

Within the remaining lifetime of the existing SEM CRM:

1. Most Carbon emissions deriving from CRM supported capacity out to 2050 come from existing plants.
2. The lack of certainty on technology and infrastructure readiness makes it challenging for existing plants to commit to *full-scale* decarbonisation (e.g. H2 or CCUS).

Principal Measures

There are 2 principal decarbonisation measures that SEMC can consider:

1. The **Green Bonus** – an additional contract duration of 1 year for new and refurbishing capacity that meets a specified CO2 threshold, and for gas units, is Hydrogen-blend ready.
2. The **Green Scalar** – a multiplier on the Capacity Payment price paid to lower Carbon technologies.

Supporting Measures

There are 2 supporting measures that SEMC can consider implementing:

1. Publication of **emissions data** for Capacity Market Units on a quarterly or annual basis
2. A qualification requirement for multiyear units to make a "**Decarbonisation Commitment**", including submitting a decarbonisation plan

ILCs

We **do not recommend an additional duration ILC**.

We consider that this would add little to the investment incentives already available to existing capacity through the standalone USPC process and the 5-year ILC option.

Cost Recovery

The mechanism for recovery of the **costs of the Capacity Market should in future be targeted** to more effectively drive implicit demand response and reduce the need for new (fossil) capacity, by targeting costs at those times when demand is driving the system need for capacity.

2 Introduction

2.1 Purpose of this Report

The purpose of this report is to set out AFRY's assessment of options for decarbonisation of the existing CRM in the SEM, and recommended avenues for SEMC to pursue to further this objective.

2.2 Structure of this Report

After the Executive Summary, and this Introduction, this report contains the following sections:

Section 3 Background – gives the background to this report, including the scope, the timeframe of relevance, and the history of decarbonisation and the SEM CRM.

Section 4 Decarbonisation Potential – presents our analysis of the potential for decarbonisation of the capacity supported under the CRM within the timeframe of the remaining lifetime of the existing design.

Section 5 Approaches in Other Markets – describes approaches to decarbonisation of Capacity Markets in selected other markets in Europe.

Section 6 Assessment Framework – details the framework we have applied in assessing the options for decarbonisation of the existing SEM CRM.

Section 7 Evaluation of Options – presents our evaluation of options for decarbonisation of the existing SEM CRM.

Section 8 Recommendations – sets out the recommendations based on our evaluation.

Annex A – contains an explanation of the theory behind energy-only market design.

Annex B – contains examples of targeted capacity cost recovery in other countries.

Annex C – contains the "Commitment to Carbon Neutrality" text included in the Functioning Rules of the Belgian CRM.

3 Background

3.1 Scope of this Report

AFRY has been engaged by the Regulatory Authorities (RAs) to support on a project to develop the SEM CRM. This project consists of two distinct workstreams.

The objective of Workstream 1 is to identify options for decarbonisation of the existing CRM i.e. the CRM design that currently has State aid approval until May 2028. This follows on from the SEM Committee's decision in relation to Intermediate Length Contracts and their consideration of decarbonisation in that context. It is also driven by the CEEAG provisions relating to decarbonisation of security of supply measures, and the objective of compliance with them.

For context, the aim of Workstream 2 is to develop a new capacity mechanism design, to be developed, consulted on and granted State aid approval, in time to be implemented once the current approved scheme expires. Workstream 2 will commence in parallel with the consultation process in Workstream 1.

This report relates specifically to Workstream 1: Options for decarbonisation of the existing SEM CRM design.

3.2 Timeframe

The first targeted auction to which any decarbonisation measures, implemented pursuant to this assessment, may apply will be that after the 2029/30 T-4 auction scheduled for next March. As the State aid approval is due to expire in May 2028, the number of T-4 auctions expected to take place during the intervening period is 2-3. The associated delivery year for these T-4 auctions is expected to be 2030-33. Any measures must therefore be capable of being:

1. Implemented within the timeframe of this first target auction, and
2. Effective at influencing participants' investment decision-making and project development within these timeframes.

3.3 Decarbonisation and the SEM CRM

The Capacity Remuneration Mechanism in the SEM was designed over the period 2015-2017 and implemented as part of the revised SEM arrangements, which went live on 1 October 2018, with the first T-4 auction taking place in March 2019.

Since the time of the CRM design, the focus on decarbonisation has strengthened considerably in Ireland and Northern Ireland, and in the EU. This is illustrated by the fact that in 2015, when the CRM design began to be developed, the renewable electricity target in both Ireland and Northern

Ireland was 40% by 2020. This target has since doubled in both jurisdictions and is now 80% by 2030.

The rules implemented in 2018, and in place currently, only give preference to lower carbon technologies in tie-break situations. This preferential treatment of low-carbon technology was driven by the requirement in the State aid Guidelines that were in place at the time[1] that measures providing aid for generation adequacy should:

> "*…give preference to low-carbon generators in case of equivalent technical and economic parameters.*"

In 2019, the EU 'Electricity Regulation' [2] came into force. This regulation – part of the EU's Clean Energy Package – substantially developed the requirements at EU level in regard to electricity, including resource adequacy. One of the measures introduced by this regulation was the requirement for CO_2 emissions limits to be incorporated into Capacity Mechanisms. A limit of 550g CO_2 of fossil origin per kWh[3] was introduced as an eligibility requirement for new capacity seeking to receive capacity payments. For older capacity that started commercial production before July 2019, this requirement was based on both the 550g CO_2 per kWh limit, and an average annual limit of 350 kg CO_2/year/kW. This meant that capacity already generating at the time the Regulation came into force could continue to receive capacity payments regardless of its CO_2 emissions per kWh, provided that its annual run hours were appropriately limited. These CO_2 limits were introduced into the SEM CRM in 2020 and are in place in Capacity Mechanisms across the EU.

In 2022, new EU State aid guidelines for Climate, Environmental protection and Energy (CEEAG)[4] were introduced. The CEEAG guidelines place a much stronger emphasis on facilitating greener technologies in allocating aid for security of electricity supply.

They envisage for example that such aid measures may be designed to:

> "*Support environmental protection objectives, for example through the exclusion of more polluting capacity or measures to give more environmentally beneficial capacity an advantage in the selection process.*"

[1] Guidelines on State aid for environmental protection and energy 2014-2020, EUR-Lex - 52014XC0628(01) - EN - EUR-Lex
[2] EU 2019/943, Regulation - 2019/943 - EN - EUR-Lex
[3] Note that the specific emissions of a unit on a g/kWh basis do not reflect the system-wide impact of a particular unit e.g. a unit with very low specific emissions may have very high marginal cost and run very little, leading to minimal overall impact on system emissions.
[4] Guidelines on State aid for climate, environmental protection and energy 2022 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022XC0218%2803%29

The guidelines encourage Member States to:

> "*Introduce additional criteria or features in their security of supply measures to promote the* participation *of greener technologies (or reduce the participation of polluting technologies) necessary to support the delivery of the Union's environmental protection objectives.*"

They also require Member States to explain how investments in new gas-fired generation will contribute to achieving the EU's climate targets, and how lock-in of these new plants will be avoided.

In 2024, the SEM Committee introduced Intermediate Length Contracts (ILCs) for the 2028/29 T-4 auction, and all future auctions until further notice. Participants can apply to the RAs to be allowed to bid for an ILC of up to 5 years, where the associated investment exceeds €100,000/$MW_{derated}$ and where post-investment, the units will emit no more than 550g CO_2 per kWh. Units bidding for an ILC are subject to the Existing Capacity Price Cap (or a Unit-Specific Price Cap, if granted).

These ILCs introduce a pathway for existing capacity to upgrade, extend its lifetime, and improve efficiency. This in itself can contribute to decarbonisation in instances where better efficiency is achieved, and by avoiding the need to procure replacement new capacity and the associated risk of longer-term lock-in, which the CEEAG refers to.

The ILCs can also provide a route for existing capacity to decarbonise, as and when substantial decarbonisation technology options such as hydrogen or Carbon Capture and Storage (CCS) for example, become viable.

The ILCs awarded in the T-4 2028/29 are listed in Exhibit 2 below. Out of the total existing gas capacity on the system, approximately one third now holds an ILC, running from Oct 2028 to Sept 2033. The implications of this, from the perspective of assessing options for decarbonisation of the existing CRM, are discussed further in Section 4.

Exhibit 2: ILCs awarded in the 2028/29 T-4 auction[5]

Party Name	Awarded Capacity (MW)	Technology Class
Whitegate (BGE)	333	Gas Turbine
Huntstown 1 (Energia)	267	Gas Turbine
Huntstown 2 (Energia)	306	Gas Turbine
ESB (Dublin Bay)	315	Gas Turbine
Tynagh (Tynagh Energy Ltd)	306	Gas Turbine
iPower	55	Gas Turbine (AGU)
Ballysumaghan Flexpower Ltd	25	Other Storage
Drumkee LCIS Ltd	14	Other Storage
ESB	31	Pumped Hydro Storage
ESB	31	Pumped Hydro Storage

[5] Appendix_B-Final-Capacity-Auction-Results-2028_29-T-4.xlsx

4 Decarbonisation Potential

Given the relatively short remaining lifetime of the existing CRM, it is important to consider the potential to drive decarbonisation of any measures now implemented.

To inform this, it is useful to categorise the carbon-emitting capacity on the system, or expected to be on the system, to allow us to understand which categories can be targeted by any decarbonisation measures implemented, and the extent of the potential impact. As a reasonable approximation, we have assumed that the carbon-emitting capacity (i.e. the capacity that could be 'decarbonised') is the gas capacity on the system. These different categories therefore are:

- **Existing Capacity without an ILC**: gas capacity that is already on the system at this time and that does not hold an ILC.
- **Existing Capacity with an ILC**: gas capacity that is already on the system at this time and that holds an ILC.
- **Pipeline Capacity**: gas capacity that has been awarded a 'New Capacity' contract but has not yet commissioned.
- **Future Capacity**: gas capacity that may be procured in future auctions from the T-4 after the 2029/30 T-4 auction in March[6] out to May 2028.

Exhibit 3 shows the amount of CRM-supported gas capacity by category. This is based on the TSOs' latest available All-Island Resource Adequacy Assessment[7] and the Base Scenario presented therein. From this graph, it can be seen that the capacity expected to be on the system (and procured though the CRM) in this scenario in the four years targeted by the decarbonisation measures is predominantly Existing Capacity without an ILC, with a very small amount of Future Capacity expected to be brought on in 2032. In the TSOs' Secure Scenario, shown in Exhibit 4, the amount of Future Capacity is significantly higher. In either case however:

- The largest pot of gas capacity over the years that remain to be auctioned is the Existing Capacity (with and without an ILC) pot, which is more than double the sum of the Contracted and Future pots across all years, even in the Secure scenario.
- The total capacity that already holds a contract – be that a New Capacity contract or an ILC – for the years that remain to be auctioned under the existing CRM, is sizeable, constituting 46% in the Base case, and 40% in the Secure case.
- **The remaining capacity – the uncontracted capacity – is the capacity that decarbonisation measures can target.**

[6] The earliest T-4 auction for which modifications from this workstream could be implemented.
[7] All-Island Resource Adequacy Assessment

Exhibit 3: Gas Capacity by Category (GW) - Base Case

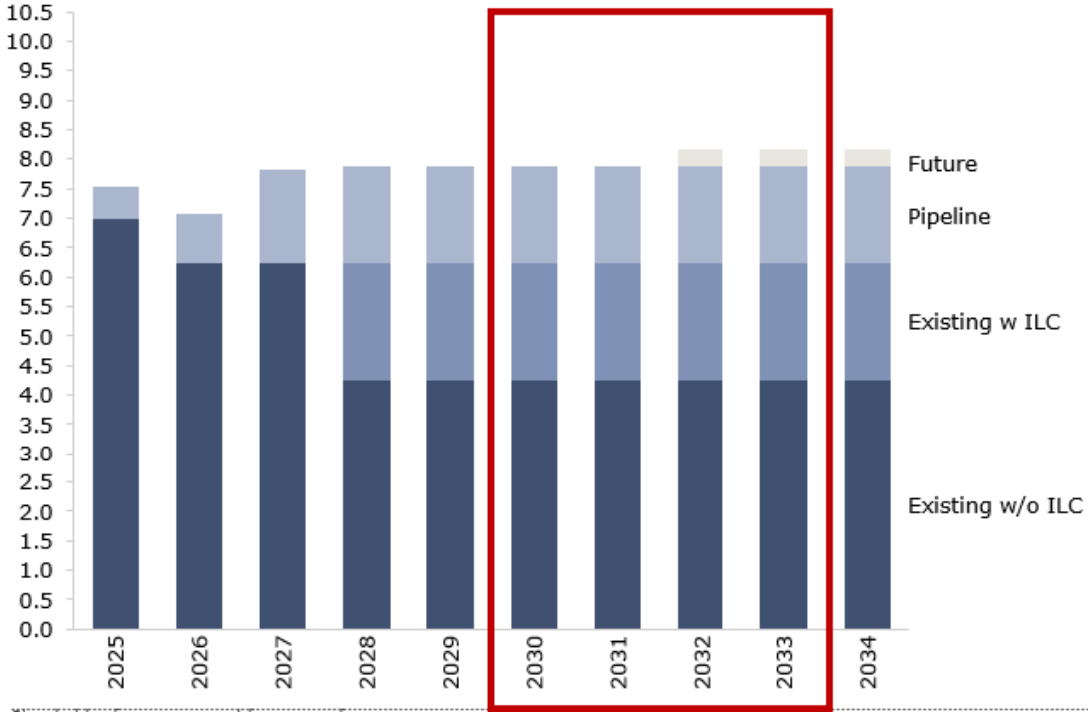
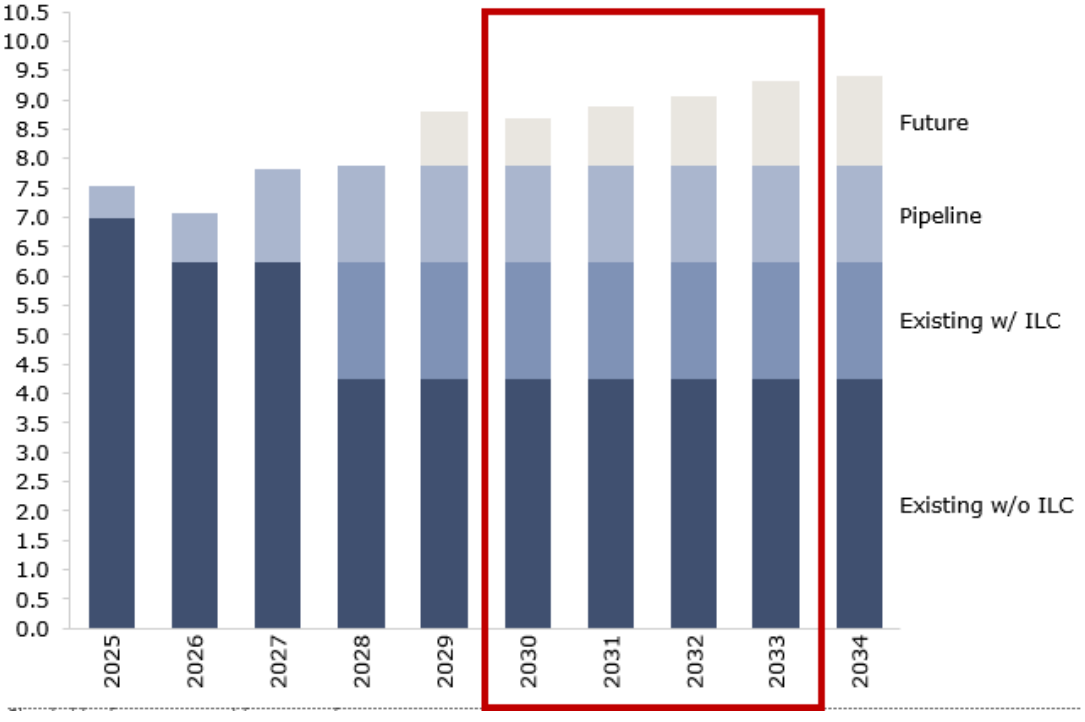


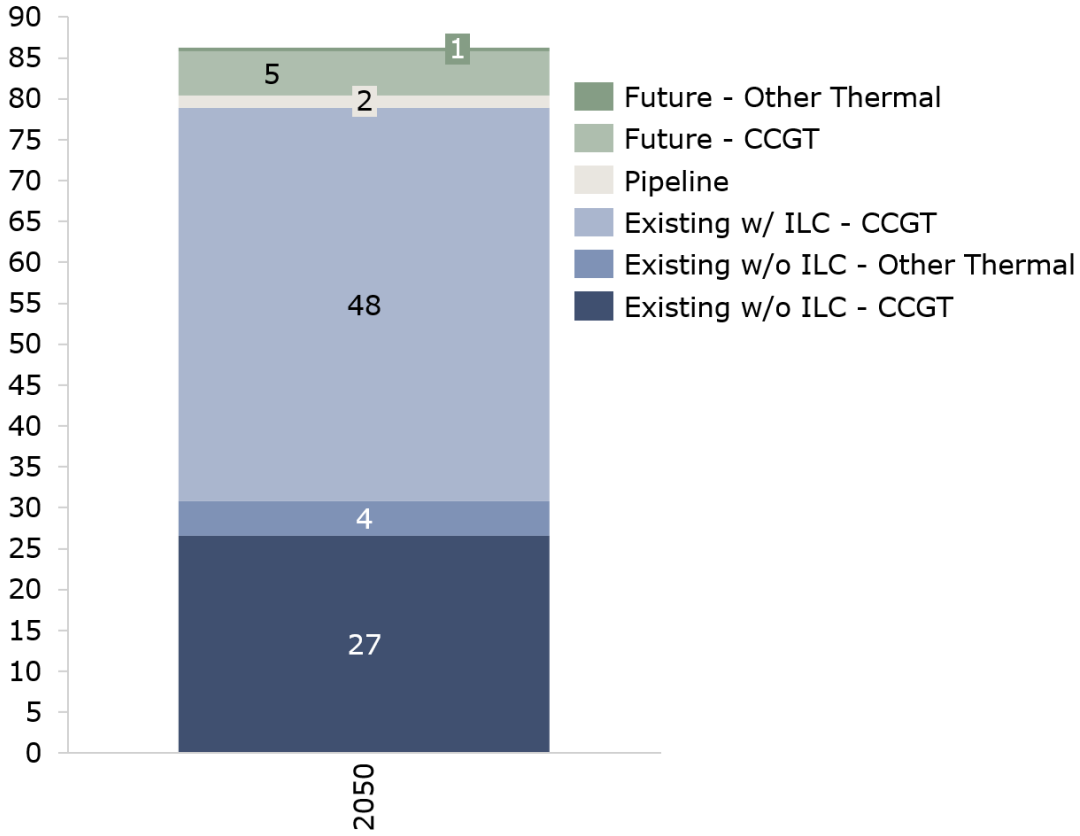
Exhibit 4: Gas Capacity by Category (GW) - Secure Case



While it is useful to understand the breakdown of capacity into these different pots, from a decarbonisation perspective it is most insightful to examine the CO_2 emissions projected to derive from each of these capacity pots.

Exhibit 5 shows AFRY's projections of the cumulative emissions associated with these four different pots of capacity, out to 2050. In this figure, the uncontracted capacity (i.e. 'Future' and 'Existing without an ILC') has also been split into 'CCGT' and 'Other Thermal', in order to illustrate the impact that technology type has on the running and emissions of the different pots.

Exhibit 5: CO_2 Emissions from Gas Capacity Across All Capacity Pots (MTonnes, Cumulative to 2050)



From this graph, it is evident that:

— Existing capacity with an ILC produces over half of the total emissions[8]. This is because this capacity is the most efficient thermal

[8] The fact that ILC capacity is expected to produce a substantial proportion of total emissions does not undermine the role of these contracts in supporting decarbonisation of the CRM, as it may be expected that analysis of the counterfactual (i.e. of a scenario where no ILCs were awarded) would reveal higher total Carbon emissions due to the absence of efficiency improvements to existing plants, and the potential procurement of new replacement fossil capacity that would run for longer.

capacity and is therefore better placed in the merit order than Existing Capacity without an ILC, or Pipeline capacity, and runs more as a result. It is also due to the impact of network constraints on the running of certain plants in this pot.

- The capacity that is as yet uncontracted (i.e. 'Future' and 'Existing without an ILC') for the target years – 2030 to 2033 – accounts for fewer emissions overall than the already contracted Pipeline and ILC capacity.
- However, a considerable proportion of the total emissions (37 out of 86 MTonnes) derive from capacity that is yet to win a contract for the years in question. These emissions can be considered to represent the outer envelope of the decarbonisation potential of the existing CRM.
- This 'decarbonisation potential' is predominantly associated with CCGT plants, as they run considerably more than other types of gas plant, and therefore emit more CO_2 in total over the period modelled. In the range 86-93% of the total emissions from gas capacity yet to be contracted under the existing CRM for the target years are associated with CCGT plant, depending on the assumptions made regarding the technology type of the Future capacity pot.

In the context of the existing CRM design, and the limited remaining lifetime of the mechanism, meeting the CEEAG requirement to avoid lock-in of new gas-fired generation (i.e. the 'Future' pot) will have a more limited impact in reducing overall carbon emissions than incentivising decarbonisation of the 'Existing without an ILC' pot.

Finally, an additional consideration in relation to Existing Capacity without an ILC is the derating factors (DRFs) associated with annual run hour limited (ARHL) plant. As it stands, ARHL DRFs apply to New Capacity only. From the year for which an Existing plant is awarded an ILC, that capacity is considered New rather than Existing Capacity. This means that there is a strong incentive for annual run hour limited plant that is Existing Capacity in the context of the CRM, and wishes to avail of an ILC, to ensure that the associated investment results in the removal of the ARHL. Where the removal of the ARHL leads to lower Carbon emissions, the application of the ARHL DRF therefore incentivises decarbonisation via the ILC process.

This understanding of the carbon emissions contribution of the different pots of capacity provides the context for the assessment of potential approaches to decarbonisation of the existing SEM CRM that is set out in what follows of this report.

5 Approaches in Other Markets

This section describes approaches to decarbonisation in other Capacity Markets in Great Britain, Poland, Belgium, France and Italy. The markets reviewed were chosen as they are most similar in their design to that of the SEM (i.e. they are based on centralised, market-wide obligations), which makes them most likely to contain measures of relevance to the SEM mechanism. In the case of the French market, this is in the process of moving from a decentralised Capacity Mechanism to a centralised scheme and has been included in the review for that reason.

5.1 Great Britain (GB)

The GB Capacity Market (CM) operates through annual T-4 and T-1 pay-as-clear auctions. Capacity Market Units (CMUs) can secure contracts of varying durations based on their capital expenditure. Until the recent amendments described below were implemented, the duration of these contracts were as follows:

- 15-year agreements for investments exceeding £325/kW;
- 3-year agreements for investments exceeding £165/kW; and
- 1-year agreements for all other CMUs.

To enhance the CM's alignment with the UK's net zero targets and improve security of supply, a multi-phase reform process was launched in 2023[9,10,11]. Pursuant to this, in early 2025, the following key decarbonisation actions were implemented[12]:

1. **Two new types of multi-year contract** were introduced in order to enable better access to the CM for a wider range of technologies:
   - A 9-year agreement for units that meet the requirements to be a "declared low carbon CMU", as well as a new Capex threshold, set at a level between the thresholds for the standard 3- and 15-year agreements.
   - A new 3-year agreement with a Capex threshold of £0/kW only available to low-carbon New Build and Unproven Demand Side Response (DSR) capacity. This new 3-year agreement was introduced with the intention to remove participation barriers for low carbon, low Capex technologies.

To be eligible for classification as "low carbon", units must not exceed a carbon emissions ceiling of 100g CO_2/kWh. This is intended to promote solutions such as storage and gas-fired generation with CCUS, while further

[9] Capacity Market 2023: strengthening security of supply and alignment with net zero (Phase 1) - GOV.UK
[10] Capacity Market: government response (2023)
[11] Capacity Market Phase 2 Consultation: government response update (15 October 2024)
[12] The Electricity Capacity (Amendment) Regulations 2025

review is planned of the appropriate methodology for accommodating biomass and other technologies with CO_2 emissions from non-fossil sources.

2. More flexibility was introduced in the approach to **the refurbishment and repowering of existing capacity market units**:

The way in which the total project spend is defined for refurbishment of existing CMUs has been amended to align the Capex cost window with that applied for new units. This is to enable refurbishing units to capture their full Capex costs and to help encourage more decarbonisation projects to come forward in the future, including those that are comparable in terms of cost and complexity with new build projects. In addition, the definition of refurbishment and repowering has been broadened, to better reflect the range of technologies and projects participating in the CM.

3. Reforms were made to **address challenges faced by Demand Side Response (DSR)**, particularly for large portfolios with domestic assets:

— A privacy enhancement, to address data protection concerns, involving the redaction of residential addresses and residential Meter Point Administration Numbers (MPANs).

— Increased flexibility on component reallocation, with the limit on reallocation of DSR components within a portfolio increased to the greater of 40 components or 20% of the portfolio size. This is intended to enable providers to better manage customer churn and delivery risks.

4. A requirement was introduced to **publish Capacity Market emissions data:**

To improve transparency in the CM, and facilitate the transition to net zero, including by supporting the monitoring of policy impacts, independently verified emissions data for each CMU will be published, and updated on a quarterly basis.

5. Increased **flexibility on long-stop dates** was introduced for projects with long build times, including low carbon new build and refurbishing assets:

Generating CMUs can benefit from an additional 24 months of construction time, where they declare at prequalification stage their intent to deliver to that timeframe. To minimise the associated security of supply risks, this was introduced as an interim measure, to be reviewed within 3 years.

5.2 Poland

The Polish Capacity Market operates through T-5 and T-1 pay-as-clear auctions. There are different capacity contracts on offer, depending on whether the capacity is classified as 'existing', 'modernised' or 'new' based on the Capex commitment and envisaged payback time[13]. The durations available are:

[13] Polish Capacity Market Rules

- 15 years for new entrants;
- 5 years for modernised, or refurbishing, units; and
- 1 year for existing capacity providers.

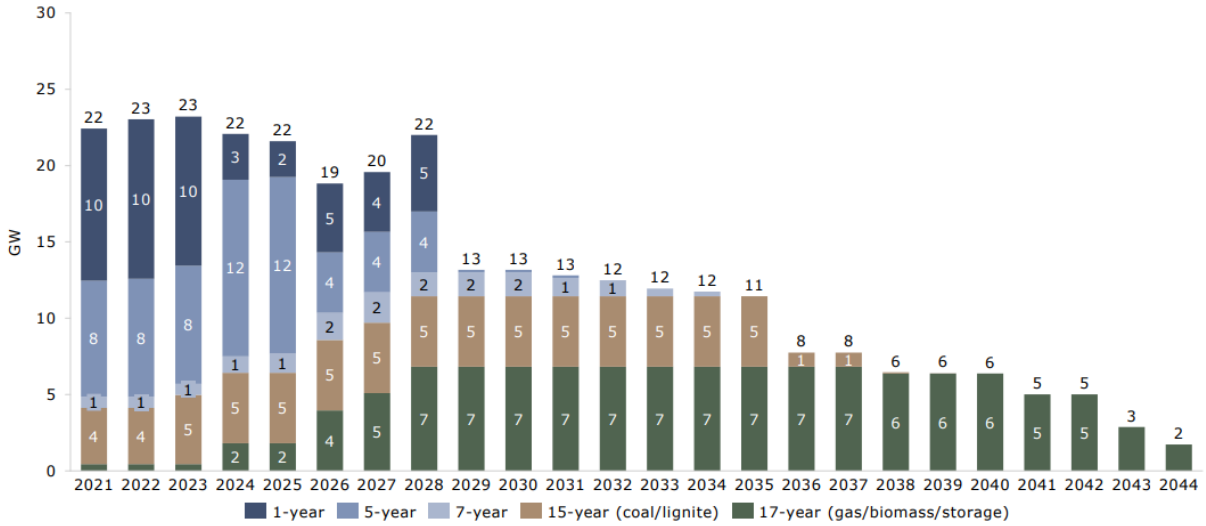
Poland has introduced targeted measures to support the transition to low-carbon electricity generation. These decarbonisation measures are as follows:

1. **Intermediate Length Contracts (ILCs):**
   Introduced in 2021 to support capital investment in existing assets, the Polish Capacity Market offers ILCs of 5 years for units undergoing significant refurbishment or modernisation. These contracts serve as a middle ground between the standard 1-year contracts for existing units and the 15-year contracts for new builds. The intent is to encourage upgrades that often lead to improved efficiency and reduced emissions, thereby supporting both system reliability and environmental goals.

2. **Green Bonus:**
   The Green Bonus in the Polish Capacity Market was introduced in 2017 at the time the market was put in place. It allows for an additional 2 years to be added to multiyear contracts (both 15- and 5-year contracts) for units that demonstrate compliance with stricter emission performance standards (450kg/kWh) at the time of application. The CMUs applying for this must maintain emissions below the limit for each year of delivery.

   Exhibit 6 below shows the capacity contracted via the Polish Capacity market to date, broken down by contract length. The 7- and 17-year contracts represent those that include the Green Bonus. The uptake of the Green Bonus has been sizeable, with up to 7 GW of new gas/biomass/storage capacity contracted under the Green Bonus, while up to 2 GW of existing units have been awarded the Green Bonus.

Exhibit 6: Total Contracted Capacity per Delivery Year in Polish Capacity Market Auctions to Date



3. **Implementation of favourable DRFs for storage:**
   To promote storage investment, storage DRFs were set at a relatively high level for the T-5 auctions for 2028 and 2029. With storage DRFs of 95% and 61% for the 2 auctions respectively, the bulk of the capacity cleared was BESS capacity. However, after the 2029 main auction was concluded, security of supply concerns emerged. The Polish Ministry identified "*an imbalance between generation sources capable of delivering capacity without time constraints and electricity storage*". The derating factor for BESS was then cut substantially from 61% in the 2029 T-5 auction to just 12% in the follow-up auction.

4. **Cross-border participation:**
   The Polish Capacity Market is open to cross-border participation, allowing foreign capacity providers to compete and win agreements. This can reduce reliance on domestic fossil capacity, while enhancing regional adequacy.

5. **Consumption-based capacity Levy:**
   The Polish Capacity Levy recoups the costs of the Capacity Market from consumers. Currently, household, and other small customers, pay a flat rate levy. All other customers are charged the capacity levy at a rate that depends on the difference between their consumption during peak demand hours and the remaining hours of the day. The flatter the demand profile, the lower the Capacity Levy that these customers pay, with adjustment coefficients of 0.17 to 1 applied to the standard rate. The aim of this charging mechanism is to promote stable and conscious electricity consumption to support the balancing of supply and demand. From 1 Jan 2028, this approach to application

of the Capacity Levy will be extended to all customers, including households[14].

5.3 Belgium

Belgium's Capacity Market involves Y-4 and Y-1 auctions operating on a pay-as-clear basis, with a Y-2 auction recently added to increase procurement flexibility. It is comparatively new, relative to other European CMs, having been approved in 2021.

As with the GB and Polish CMs, different contract durations are available depending on the status of the capacity (new or existing), and the level of investment planned:

- 15-year contracts for new build units;
- 3-year contracts for units that meet a specified investment threshold;
- 8-year contracts for units that meet a higher specified investment threshold; and
- 1-year contract for existing units.

The Belgian CM has been developed to include various measures to facilitate decarbonisation, as follows:

1. From the outset, Belgium required a **signed decarbonisation commitment** from CMUs:

Belgium requires parties wishing to apply for pre-qualification for a multiyear contract (of any duration) for new fossil capacity to formally recognise that obtaining a contract does "*not exempt them from current and future legislation and objectives established by the European Union and/or Belgium to reduce greenhouse gas emissions*". In addition, these parties must acknowledge that obtaining a capacity contract commits them to contributing to policy preparation to achieve these objectives.

To this end, these applicants must attach a written declaration[15] in which they undertake to:

- study the technical and economic feasibility of reducing greenhouse gas emissions,
- establish an emissions reduction plan indicating how the unit in question will contribute to the transition to carbon neutrality in 2050, with interim objectives for the years 2035 and 2045, and
- achieve zero or negative emissions by 2050.

2. **Cross-border participation:**

Foreign capacity has been able to participate in the Belgian CM since the 2025 Y-1 auction, which was held in 2024.

[14] Capacity levy for 2025 published by President of URE - News - Energy Regulatory Office
[15] Belgian Capacity Market Code

3. **Lowering the carbon emissions ceiling:**

Belgium committed to progressively lowering carbon emissions thresholds within its CM through the 2023 State aid approval process[16].

For the Y-4 auction in 2022, only capacity with a maximum emission rate of 550 g CO_2 of fossil fuel origin per kWh of electricity could pre-qualify, regardless of when it started production. This was a tighter requirement than that obligated by EU legislation as it removed the flexibility to manage the emissions of older plants by limiting their running hours.

For the Y-4 in 2023 however, this requirement was amended in the case of older plants (that started commercial production before 4 July 2019) to exclude any such capacity that:

> "*either emits more than 306 kg CO2 of fossil fuel origin on average per year per installed kWe or more than 600 g of CO2 of fossil fuel origin per kWh of electricity*".

This amendment is to be the first step of a trajectory to reduce the CO_2 threshold and applies until the 2031/32 delivery period. The effectiveness of the emissions reduction trajectory is to be monitored and adapted if needed, with any new emission limits to be formally notified to the European Commission before implementation. Belgium is currently developing a strategy to implement stricter emission thresholds starting with auctions from 2028.

4. **New investment thresholds for existing capacity** to access 3- and 8-year contracts:

Through the 2024 State aid approval[17], the Belgian CM now differentiates between the investment threshold for new and existing capacity to access multi-year contracts, thereby providing access for existing capacity to these contracts.

5. **Y-2 auctions:**

The 2024 State aid approval formally introduced the T-2 auction into the Belgian CM framework. The aim of the T-2 auctions is to accommodate the development timing of certain technologies, which have a lead time of more than 1 year, but less than 4, such as BESS in particular.

6. **Removal of payback obligation for non-fossil technologies (DSR and BESS):**

Similar to the operation of the Reliability Option in the SEM, the Payback Obligation in the Belgian CM ensures that capacity providers reimburse excess revenue earned when energy market prices exceed a predefined Strike Price. Belgium made the case that this obligation endangered participation in the CM of those technologies (specifically DSR) whose marginal cost can be above the strike price.

[16] SA.104336 (2023/N),
[17] SA.114003

The 2024 State aid approval allowed Belgium to exempt DSR from the Payback Obligation from 2024 onwards, and to extend this to storage from 2025 on the grounds that this would avoid discrimination among non-fossil technologies and help further environmental objectives.

Other mechanisms are to be used to monitor the delivery of the relevant contracted capacity at times of scarcity.

5.4 France

The current capacity mechanism – the Capacity Obligation Mechanism – was introduced in 2017 and is due to remain in place until Winter 2026. It is a fully decentralised mechanism, allowing market participants to trade certificates bilaterally before, during, and after the delivery year.

However, in February 2025, the French government announced a consultation on the reform of the mechanism[18], with the intention to move to centralised capacity auctions. A first decision paper was released in July 2025[19], setting out that the new CM will involve the following features[20]:

- Pay-as-clear auctions,
- A primary Y-4 auction for each delivery period, with a balancing auction at Y-1 intended to address variations in demand in the intervening timeframe, and
- Multiyear contracts that will be awarded in the Y-4 auctions only and will have a maximum duration of 15 years.

Although the details of the mechanism are still in development, there is one notable high level design feature related to decarbonisation, which is the integration of non-fossil flexibility procurement into the auctions.

Reserved Volume for Decarbonised Flexibility:
The primary auction will be technology neutral, while the Y-1 auction will include a volume reserved for decarbonised flexibility, clearing at a separate price to other technologies. The objective of this dedicated process is to facilitate the development of decarbonised flexibility that is not competitive at Y-4. This is driven by the requirements of the 2024 EU Electricity Market Design Directive[21] to adapt the design of CMs to promote the participation of non-fossil flexibility, such as demand side response and energy storage.

5.5 Italy

The Italian capacity market was introduced in 2017. It features a T-4, and a T-1 auction, with 1-year contracts for existing capacity and 15-year contracts for new builds.

[18] Consultation publique mécanisme de capacité
[19] Synthèse des réponses - Consultation publique mécanisme de capacité
[20] Prepare for the new capacity mechanism - RTE Services Portal
[21] EU Electricity Market Design Directive (2024) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202401711

The market is open to cross-border participation, with foreign capacity subject to specific caps and required to follow nomination rules for delivery into adjacent Italian zones.

While there are no explicit decarbonisation mechanisms within the CM itself, Italy has recently introduced a parallel storage procurement mechanism called MACSE (Mechanism for the Acquisition of Storage Capacity), which is designed to complement the CM.

MACSE offers long-term contracts to new-build storage via a competitive auction process. Certain reference technologies are specified for each auction, which are deemed feasible, and capable of meeting the storage requirement. Currently, the technologies defined as "reference" technologies are Lithium-ion batteries and Pumped Storage. Other storage technologies may participate in the auction but are limited to 10% of the total volume procured.

For each bidding process, multiple auctions are to be conducted, each corresponding to a specific group of reference technologies. A specific planning horizon and delivery period are defined for each reference technology. The first auction was held in September 2025, based on the Lithium-ion battery reference technology, where contracts were awarded with a planning horizon of 2 years and a delivery period of 15 years.

A long-term auction is also planned – based on the Pumped-Storage reference technology, where contracts will be awarded with a planning horizon of 6 years and a delivery period of 30 years.

6 Assessment Framework

This Section describes the Assessment Framework that we have applied to this project and explains how we have arrived at a shortlist of options for further evaluation. An overview of the framework is illustrated in Exhibit 7.

Exhibit 2: Framework used to assess options for decarbonisation of the SEM CRM.

6.1 Identifying Options

We have cast a wide net to identify a longlist of options for decarbonisation of the SEM CRM. The sources that we have drawn on in producing the longlist comprise:

- the decarbonisation measures implemented or considered internationally, as summarised in Section 5;
- previous proposals considered by SEMC, and suggested by industry respondents, in the context of the consultation on ILCs;
- examples given in the CEEAG guidelines of decarbonisation measures that could be implemented in CMs; and
- our in-house market design expertise.

The resulting longlist of options is contained in Exhibit 8. These have been grouped into the following categories:

- explicit decarbonisation obligations;
- explicit decarbonisation incentives;
- targeted low carbon procurement;
- derating factors; and

— supporting measures, which are less directly linked to decarbonisation that the other categories but can nonetheless help to reduce the carbon emissions impact associated with the CRM.

The intention at the longlisting stage is not to yet judge the suitability or effectiveness of the options, but simply to identify them. Some measures would represent substantial change (and therefore potentially be more relevant for Phase 2), while others would require minimal change.

Exhibit 8:1 Longlist of options for decarbonisation of the SEM CRM

	Option	High-level Description	Impacted Capacity
Explicit decarbonisation obligations			
1	Contractual obligation for closure of high-carbon capacity	Introduce defined timelines for the retirement (or strategic reserve transition) of high-carbon units in line with climate targets.	Future Existing w/o ILC
2	Incentive or Obligation to transition to CCUS over time	Incentivise or obligate fossil fuel plant to integrate CCUS specifically, through eligibility criteria for example.	Future Existing w/o ILC
3	Incentive or Obligation to transition to renewable fuels over time	Incentivise or obligate fossil fuel plant to use low-carbon alternatives such as biomethane, hydrogen.	Future Existing w/o ILC
4	Reduction of CO_2 emission limit over time	Tighten the emission ceiling for participation in the CRM from the maximum value of 550g CO_2/kWh over time.	Future Existing w/o ILC
Explicit decarbonisation incentives			
5	"Green Bonus" for low-carbon capacity	Offer additional contract length to new and refurbishing units that meet a tighter emissions threshold.	Future Existing w/o ILC
6	"Green Scalar" for low carbon capacity	Apply a scalar to the bids of low carbon units during the auction to enhance their competitiveness.	Future Existing w/o ILC
7	3-year Intermediate Length Contracts with no investment threshold	Introduce a new 3-year ILC with a €0/kW investment threshold for capacity that meets a substantially lower emissions limit e.g. 100g CO_2/kWh.	Existing w/o ILC
8	3-year Intermediate Length Contract with lower investment threshold	Introduce a new 3-year ILC with an investment threshold lower than that of a 5-year ILC to capture smaller scale efficiency upgrades of existing plant.	Existing w/o ILC
9	Longer long-stop period for low-carbon capacity	Make available an optional longer long stop date for low carbon projects with longer build times.	Future
Targeted low carbon procurement			
10	Separate dedicated procurement of low carbon capacity	Create a separate procurement process dedicated to low-carbon capacity.	Future

11	Minimum volume target in the CRM for low carbon capacity	Set a minimum target for low carbon capacity in the capacity auctions.	Future Existing w/o ILC
12	Minimum volume target for non-fossil flexibility	Set a minimum target for non-fossil flexible capacity in the capacity auctions.	Future
Derating Factors to drive decarbonisation			
13	Progressive reduction of DRFs for unabated fossil capacity	Gradually decrease DRFs for high-carbon capacity, including over the course of the delivery period for units with long-term contracts.	Future Existing w/o ILC
14	Favourable DRFs for low-carbon capacity	Set favourable DRFs for lower carbon capacity.	Future Existing w/o ILC
Supporting measures			
15	Transparency of emissions monitoring	Publish CO_2 emissions data for capacity market units on a regular basis and potentially expand scope of emissions monitoring requirements.	Future Pipeline Existing w/o ILC Existing w/ ILC
16	Targeted recovery of CRM costs	Target the recovery of CRM costs at those times when demand is driving the system need for capacity, to promote implicit demand response and ultimately reduce the requirement for new capacity.	Future
17	Incentivise explicit demand response by optimising capacity market arrangements for DSUs.	Review CM arrangements to identify opportunities to optimise participation from DSUs.	Future
18	Cross-border participation in the SEM CRM	Facilitate participation of cross-border capacity in the SEM to support access to foreign low carbon capacity.	Future
19	Decarbonisation commitment from CRM participants	Require successful participants in the CRM to adopt a commitment to decarbonise in line with climate obligations.	Future Existing w/o ILC

6.2 Screening

This longlist has been screened against the following criteria:

- Compliance with CEEAG guidelines;
- Implementable within timeframe of the next T-4 auction after the 2029/30 T-4 in March 2026; and
- Being considered or progressed elsewhere.

On this basis, the options shown in Exhibit 9 below have been screened out.

Exhibit 9: Options and Rationale for Screening Out

Option	Rationale for Screening Out
Separate dedicated procurement of low carbon capacity	— Not feasible to develop within the timeframe. — May not be compatible with CEEAG.
Minimum volume target for non-fossil flexibility	— Will be progressed in the context of the Flexibility Needs Assessment and be a focus of Phase 2 of this work.
Incentivise explicit demand response by optimising capacity market arrangements for DSUs.	— Although we see much potential in explicit demand response, a full review and optimisation of market arrangements for DSUs is not feasible within the timeframe of Phase 1 (and would sit better within the scope of Phase 2). — Certain elements are being looked at elsewhere, including the question of unit-specific DRFs for DSUs.
Cross-border participation in the SEM CRM	— Being progressed elsewhere.

6.3 Consolidation

The options remaining, after screening of the longlist, have been consolidated. In this process, conceptually similar options have been grouped, and the optimal representative option from each group has been brought through to the evaluation stage. In carrying out this consolidation and identifying a single representative option to take forward, we have applied the following guiding principles:

An obligation to decarbonise is not appropriate. Given the timeframe that is relevant for this work (i.e. based on the expectation that the first impacted auction will be the one after the 2029/30 T-4 auction in March and the last in 2028, with the delivery periods beginning in the range 2030-33), we believe that it is not appropriate, or likely to be effective, to introduce measures at this time that are intended to *obligate* decarbonisation of contracted capacity. This is because of the uncertainty around the deployment of the range of low carbon technologies for power generation in SEM within this timeframe. That is, it is not certain that developers would be able, within the remaining lifetime of the existing CRM, to either meet, or commit to meeting at a specific future time, an obligation to decarbonise, other than through plant closure, which might threaten future security of supply. For this reason, in consolidating similar options, we have favoured incentive approaches over obligations, with the idea that incentives will facilitate decarbonisation if the technology does become viable, without creating risk to security of supply.

This approach is supported by the review of decarbonisation measures implemented in other countries in that almost all of these measures are intended to facilitate or incentivise lower carbon, rather than obligate it. Only in Belgium, has somewhat more of a "stick" approach been taken so far, though even in this case it is relatively light touch. Although in Belgium, the carbon emissions threshold for parties receiving capacity payments has been amended relative to the values in the EU 2019 Electricity Regulation, these changes are minimal.

Initially, the annual limit of 350 kg CO_2/kW/year for older units was removed in the Belgian CRM, which tightened the requirement for these units in that their emissions could no longer be managed through their annual run hours. However, the following year, this was altered to reintroduce an annual limit of 306 kg CO_2/kW/year, alongside an increased specific limit of 600 g/kWh for older plants. It is not immediately clear the extent to which these limits now in place in Belgium represent a more stringent approach than that required by the Electricity Regulation, and in place in the SEM. The current approach in Belgium is due to remain in place out to the delivery period 2031/32. They have committed to reviewing this approach in time for auctions taking place in 2028, with the intention to continue moving the threshold on a downward trajectory.

As described in Section 5.2, the Belgian CRM also requires a signed decarbonisation commitment from participants. While we do consider that this may have some value for the SEM (and we discuss this further in Section 7.7) it is not apparent what the impact of this commitment will be in practice, and what the consequences would be of it not being met, particularly due to circumstances outside of the participant's control e.g. insufficient supply of low carbon fuel, or lack of necessary infrastructure or of supporting policies.

ACER's 2024 SoS Monitoring report points to this question also:

> "*In Belgium, capacity providers entitled to long-term contracts should commit to achieving climate neutrality by 2050 and develop a concrete roadmap. However, for now, the feasibility of those commitments has not been validated.*"

DRFs should not be amended to reflect low carbon. We believe that Derating factors should not be used to incentivise, or disincentivise, technology types based on their carbon emissions. DRFs are intended to capture the adequacy contribution of each technology that participates in the CRM. While amending DRFs is a simple way to assign greater (or lesser) value to a given technology type, this leads to a situation where the adequacy contribution of that technology is either over or under-stated – an effect that then needs to be corrected in the determination of the capacity requirement.

The alternative way to assign greater value to low carbon technology is through either contract duration or price. These options – the "Green Bonus" and the "Green Scalar" – are developed further in Section 7.

Having consolidated the options and applied these guiding principles, the shortlist of options we have identified for further development and evaluation are as set out in Exhibit 10 below:

Exhibit 10: Shortlisted Options and Descriptions

Option	High-level Description
Explicit decarbonisation incentives	
"Green Bonus" for low-carbon capacity	Offer additional contract length to new and refurbishing units that meet a tighter emissions threshold.
"Green Scalar" for low carbon capacity	Apply a scalar to the bids of low carbon units during the auction to enhance their competitiveness.
3-year Intermediate Length Contracts	Introduce a new 3-year ILC with a €0/kW investment threshold for capacity that meets a substantially lower emissions limit e.g. 100g CO_2/kWh.
	Introduce a new 3-year ILC with an investment threshold lower than that of a 5-year ILC to capture smaller scale efficiency upgrades of existing plant.
Longer long-stop period for low-carbon capacity	Make available an optional longer long stop date for low carbon projects with longer build times.
Supporting measures	
Transparency of emissions monitoring	Publish CO_2 emissions data for capacity market units on a regular basis and potentially expand scope of emissions monitoring requirements.
Targeted recovery of CRM costs	Target the recovery of CRM costs to promote implicit demand response and ultimately reduce the requirement for new capacity.
Decarbonisation commitment from CM participants	Require successful participants in the CRM to adopt a commitment to decarbonise in line with climate obligations.

6.4 Evaluation

We have developed each of these options, and evaluated them against the following criteria:

- Decarbonisation impact, taking into account the assessment of the Decarbonisation Potential of the existing CRM described in Section 4.
- Deliverability of the change, including complexity, timeline and risk.
- Does not interfere with the objectives of the existing CRM design, defined as follows:
  - To promote the interests of consumers with respect to price, quality, reliability, and security of supply of electricity; and
  - To promote competition, transparency and to ensure no undue discrimination.

The results of this evaluation are presented in the next section of this report.

7 Evaluation of Options

The evaluation of each of the shortlisted options against the defined criteria is set out in this section.

7.1 Green Bonus

As detailed in Section 5.2, the Green Bonus has been in place in the Polish Capacity Market since its inception. It is intended to encourage investment in cleaner technologies by offering longer revenue certainty and thereby supporting access to financing. It is one of the few dedicated incentives for low carbon capacity across European Capacity Markets.

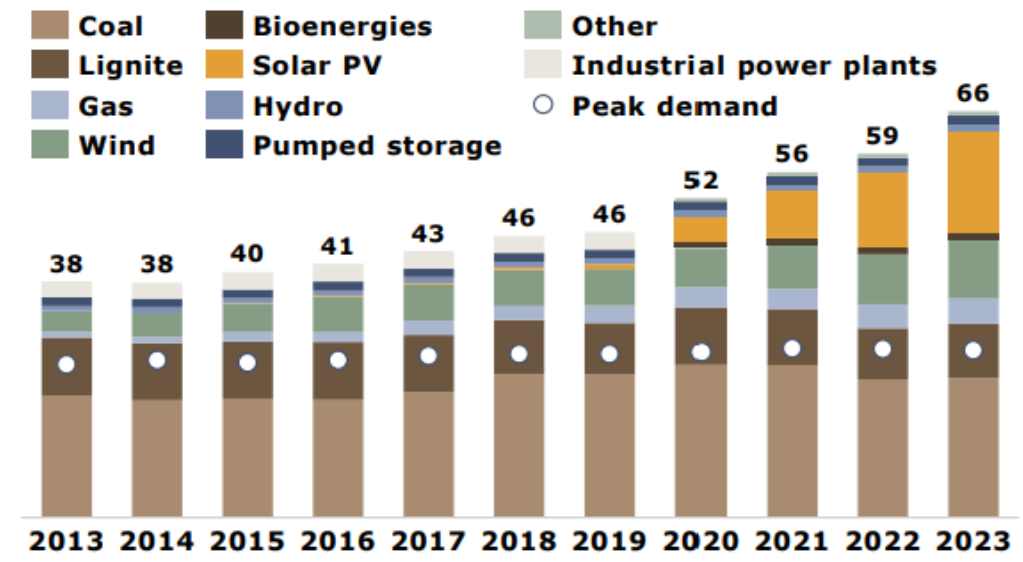
How this might work in the SEM:

An additional contract duration would be made available for multiyear contracts – both 10-year[22] New Capacity contracts and 5-year ILCs – where the participant could demonstrate that the capacity would not exceed a specified Carbon emissions threshold. This capability would need to be verified ex-ante and potentially confirmed ex-post by an independent expert (see Section 7.6 for further discussion of emissions validation and monitoring).

In Poland, the specific emissions threshold applied is 450g/kWh. This is in the context of the Polish generation fleet, which is dominated by coal and lignite capacity, as illustrated in Exhibit 2. The threshold of 450g/kWh corresponds to relatively efficient gas units, as can be seen from Exhibit 312. The principal purpose of this threshold in the Polish context is therefore to incentivise a move away from coal and lignite towards lower carbon capacity, including gas. A range of technologies have been contracted under the Green Bonus including CHP, biomass cofiring and BESS, as well as CCGT with improved efficiency.

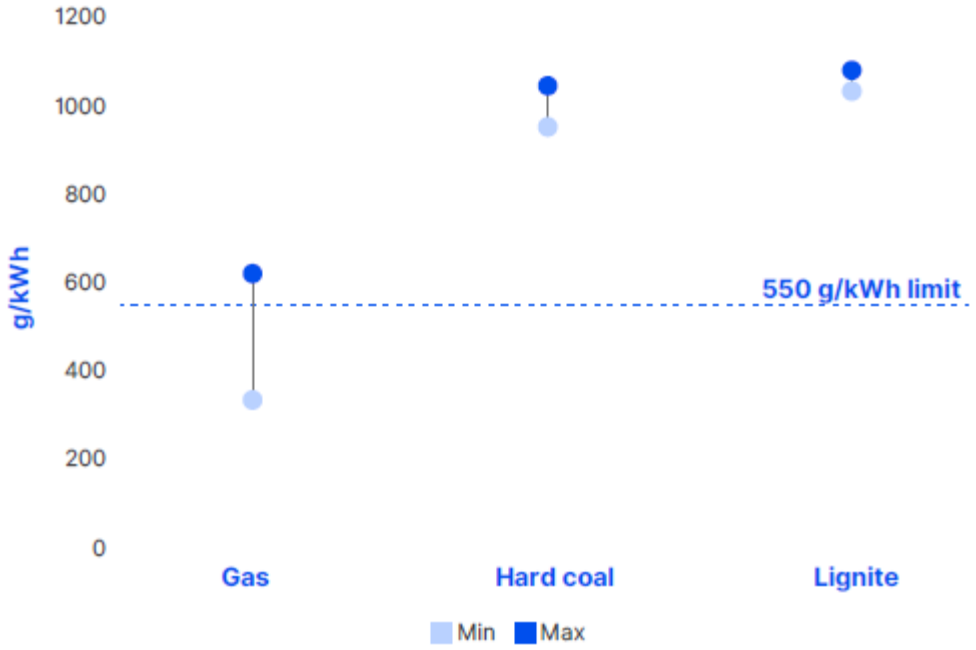
[22] Note that this would mean locking in derating factors for new capacity awarded the Green Bonus for a period of 12 years.

Exhibit 21: Installed capacity in Poland by technology type (GW).



Sources: PSE and URE (until 2019), ARE (2020-2023)

Exhibit 3: Ranges of CO_2 emissions from gas, hard coal and lignite-fired plants (g/kWh)



Source: Created by ACER based on Ember, European Electricity Review 2024.

The capacity mix in the SEM is markedly different, with no remaining coal capacity now on the system. As such, this emissions threshold could either:

1. Be set at a level that would create an incentive for existing gas plant to upgrade its efficiency and similarly for new gas plant (or other technologies) to have a certain efficiency; or
2. Be set at a significantly lower level (such as that used to define "low carbon" in the GB capacity market, of 100g CO_2/kWh) to incentivise substantially lower carbon technologies.

It is not clear what deployable technologies would be capable of meeting a substantially lower threshold within the timeframe of relevance, particularly in view of the fact that the bulk of the targeted emissions are associated with existing CCGTs (as set out in Section 4).

The ILCs already introduced have created a route for existing gas (and other) plant to upgrade their efficiency. However, they are only required to fall below the 550g/kWh threshold post-investment. This threshold would be lowered for plants wishing to avail of the Green Bonus. The precise value of the threshold should be determined though consultation with industry stakeholders.

In addition, for gas plants wishing to avail of the Green Bonus, a requirement could be implemented for these units to be hydrogen-ready, that is, capable of combustion of a specified blend of hydrogen and natural gas – on the order of 30 vol%[23] – without the need for further investment in the combustion equipment of the plant. A hydrogen blend of up to 30 vol% would strike a balance between the developing technical capabilities of commercially available gas turbine technology and the current policy positions of Government in Ireland[24] and Northern Ireland[25] regarding hydrogen blending in the gas transmission networks.

Based on these two eligibility criteria, we consider that in the SEM context a one year Green Bonus would be more appropriate than a two year one, which may risk overcompensating units where the emissions threshold is set so as to also incentivise improved efficiency of gas units, as well as lower carbon technologies.

The evaluation of the Green Bonus as a decarbonisation option for the SEM is set out below, along with a summary of the advantages and disadvantages of this option:

[23] Based on the technical capabilities of commercially available gas turbines, including as summarised in a study commissioned by National Gas Transmission in the UK: Hydrogen Acceptability Summary Report.pdf
[24] Ireland-National-Hydrogen-Strategy.pdf
[25] NI Consultation on a Sustainable, Regional Approach for the Production, Storage, Transport and Use of Hydrogen as a Fuel

Advantages	Disadvantages
— Relatively simple concept. — Potential for quick implementation as should not involve IT system changes. — Has a precedent in the Polish CM, which has been granted State aid approval. — Could be used to target both existing and new capacity.	— Not clear what technologies could respond to an incentive based on a substantially lower threshold within the relevant timeframe. — Creates an additional administrative burden associated with verification that the CO_2 threshold is respected.
Evaluation	
Decarbonisation impact	
Deliverability	
Does not interfere with existing CRM objectives	

7.2 Green Scalar

The Green Scalar is a concept that is not currently implemented in other Capacity Markets across Europe, but that has precedent in other contexts as a means of capturing the additional value offered by certain participants in a given procurement process. The concept is that a scalar is applied to the bid price of projects in the auction, reflecting their Carbon emissions intensity. The lower the emissions intensity, the lower the scalar, and the more competitive the unit appears in the auction.

The "Evaluation Correction Factor" (ECF) was introduced into the **Irish RESS** scheme as of the second RESS auction and is intended to capture the broader system-level impacts of certain technologies, which are not captured in the bid price alone. The stated purpose of the ECF is to account for differences in energy capture prices, capacity value, system costs, reliability benefits etc. This factor is applied during the bid evaluation stage in order to rank bids and determine winners in the auction. It does not affect the level of support payments made to winning bidders. For RESS-2 for example, the ECF was set at 1 for all technologies except for solar and hybrid solar, with the ECF for solar set at 0.9. This meant that bids from solar plants appeared 10% cheaper in the auction than they actually were.

A similar approach is applied in the **Italian MACSE** scheme (described in Section 5.5) to capture the value associated with storage duration and round-trip efficiency. In this scheme, a performance coefficient is applied to each bid to reflect the storage duration and round-trip efficiency relative to a defined standard storage asset (a 4-hour asset with 85% round-trip efficiency). These adjustments shift bids in the merit order, with lower coefficients meaning bids are treated as cheaper while higher coefficients mean bids are treated as more expensive.

Both the Irish RESS and the Italian MACSE schemes are pay-as-bid. The actual price successful participants are paid is the price they bid before

application of the scalar. In the case of a pay-as-clear auction, such as the SEM CRM auctions, the question arises as to how the clearing price should be set – based on the scalar-adjusted bid price of the marginal unit, or the original bid price.

An alternative approach therefore is to apply the green scalar after the auction has cleared. In GB, a number of approaches have recently been considered[26] to allow for price differentiation between categories of Capacity Auction participants. These included the application of a category-specific price multiplier, whereby the auction would initially clear as one and a pre-determined multiplier would be applied afterwards for successful eligible units.

How this might work in the SEM:

This section describes the approach whereby the Green Scalar is applied to the capacity payment price after the auction has cleared, rather than to the bid price of the unit. A scalar value of 1 would be applied to the capacity payment price of successful units with emissions at the 550g/kWh threshold, and a function would be defined such that this value would increase as the emissions intensity decreased. This scalar could be a continuous function, or a stepwise function based on defined Carbon emissions intensity ranges that could ultimately be tailored to particular technologies. The values would be published in advance of the auction in order that participants could account for them in their bidding strategies.

A further evolution of this design would be to link the Green Scalar inversely to the price of Carbon, such that it provides a form of Carbon price support similar to that in place in GB[27] (albeit not linked to the capacity mechanism itself). This would mean that the incentive created for lower Carbon technology through the Green Scalar would be regularly balanced against the penalty for higher Carbon technology, which the Carbon price constitutes. When the Carbon price was high, the Green Scalar could be lower (closer to 1), and vice versa.

Compared to the Green Bonus, which operates on the basis of a single CO_2 emissions threshold, this option would allow more nuance in differentiating between technologies with different Carbon emissions intensities. Applying

[26] Consultation on changes for Prequalification 2026

[27] Ideally, the carbon price (in the ETS) would deal with decarbonisation whereas the CRM would deal with generation adequacy and would not need to give additional consideration to decarbonisation. In practice using carbon pricing alone would likely lead to extremely high and volatile prices for carbon and for electricity. In addition, there are other support mechanisms (e.g. RES support and energy efficiency targets) in place which in turn undermine the carbon price, meaning that some of the 'externality' of carbon emissions is not reflected. In this context, it is reasonable to consider whether the CRM itself should be adapted to give an advantage to low-emissions capacity, and whether the degree of advantage should itself relate to the actual traded price of carbon in the ETS compared to a counterfactual in which CO_2 pricing is the primary driver of decarbonisation. This is the principle underpinning the Carbon Price Support mechanism in GB, which was calculated to close the gap between the traded carbon price and the carbon price trajectory determined by the UK Committee on Climate Change.

the scalar to the capacity payment price of successful units may obviate the requirement for IT system changes that would likely arise if it were to be applied as part of the auction process, as well as avoiding interaction with the clearing price. However, the Green Scalar is untested in the context of Capacity Markets in the EU and has not been the subject of a State aid application that we are aware of. It is therefore likely to involve more time and risk to develop and implement than the Green Bonus.

The advantages and disadvantages of the Green Scalar option are summarised in the table below:

Advantages	Disadvantages
— The Green Scalar allows for more nuance in differentiating between technologies with different Carbon emissions intensities. — Would not require IT system changes when applied to the capacity payment price of successful units.	— Untested in the context of European Capacity Markets. — Likely to be more involved and higher risk from a State aid perspective.
Evaluation	
Decarbonisation impact	
Deliverability	
Does not interfere with existing CRM objectives	

7.3 Additional Intermediate Length Contract

We have considered the possibility of introducing an alternative duration of ILC as a means of facilitating decarbonisation of the existing CRM, given that there are a range of durations available in other markets that either target low carbon capacity or aim to incentivise different scales of refurbishment.

As of the 2028/29 T-4 auction, held in December 2024, ILCs are available through the SEMC CRM for a period of up to 5 years, for units that:

— will be investing more than €100,000/MWd (the Intermediate Contract Investment Rate Threshold (ICIRT)); and
— will emit no more than 550g CO_2/kWh, post investment.

In addition, for units subject to run-hour limits, investment under an ILC should aim to remove the restriction on run hours or, at the least, not exacerbate it.

While the Green Bonus, applied to an ILC, would provide an investment pathway for upgraded units that achieve a tighter emissions threshold post-investment, we have considered whether or not there may also be merit in providing a pathway to a shorter term ILC.

A 3-year ILC for "low carbon" capacity, was introduced into the GB Capacity Market in 2024, with zero capex threshold and an emissions threshold of 100g CO_2/kWh. However, this type of ILC relates to "low carbon" capacity in the form of plants that either have no operational CO_2 emissions or are gas-fired with CCUS. CCUS in GB has entered a significant phase of development, with government backing, infrastructure deployment and commercial projects underway. It is at an earlier stage of development in Ireland and Northern Ireland, and is not therefore a viable investment route for existing capacity within the timeframe of relevance for this assessment. Other types of technology that would enable existing, or new capacity, to meet this low an emissions threshold within the given timeframe, are also at an early stage within the SEM. On this basis, we have discounted the option of a shorter-term ILC for low carbon capacity with an emissions intensity on the order of 100g CO_2/kWh.

An alternative 3-year ILC, associated with a lower Investment Rate Threshold and with an emissions threshold of 550g/kWh, could aim to capture investments intended to improve efficiency only, where such investments would not meet the ICIRT for a 5-year contract, without significant lifetime extension measures being carried out (perhaps unnecessarily). However, we consider that this 3-year contract would add little to the investment incentives already created by the 5-year ILC, in combination with the Unit-Specific Price Cap (USPC) process and the possibility to recover future investment incorporated within it. As such, the decarbonisation impact would be minimal.

Advantages	Disadvantages
— Relatively simple change, following precedent of 5-year ILCs already introduced.	— Very low decarbonisation impact as adds little incremental value to the investment routes already in place for existing capacity.
Evaluation	
Decarbonisation impact	○
Deliverability	●
Does not interfere with existing CRM objectives	●

7.4 Longer Long-Stop Period for Low-Carbon Capacity

This option is modelled on that recently introduced in the GB Capacity Market in order to provide greater flexibility for projects with long build times, including low carbon new build and refurbishing assets. Generating units could avail of an additional 24 months of construction time, where they declared at qualification stage their intent to deliver to that timeframe. The Capacity contract duration would be eroded by the additional construction time availed of.

While this would be a relatively simple change to implement, we consider that it would create a high level of risk to security of supply within SEM, and

is not well aligned therefore with the existing objectives of the CRM. We note that in the GB context, this measure has been introduced as an interim measure, due to the potential security of supply risks associated with it, and is to be reviewed within 3 years.

Advantages	Disadvantages
— Relatively simple change to implement.	— Security of supply risk.
Evaluation	
Decarbonisation impact	
Deliverability	
Does not interfere with existing CRM objectives	

7.5 Targeted Cost Recovery

The costs of the Capacity Market in the SEM are currently recovered via the Supplier Capacity Charge, which applies throughout the year based on electricity consumption between 07:00 and 23:00 each day. It is applied uniformly across all consumer categories. While the charge does apply only during certain hours of the day, it is not targeted at periods of peak demand or tightest margin.

The CEEAG Guidelines reflect the view that the costs of a security of supply measure should be borne by the market participants who contribute to the need for the measure, and state that:

> "*For example, this may be achieved by allocating the costs of a security of supply measure to electricity consumers in periods of peak electricity demand…*"

The benefit of targeted cost recovery is that it introduces a financial exposure for those participants who create the need for the security of supply intervention. This exposure acts to send price signals to the participants, in this case consumers, so they can adjust their consumption, reducing system stress and ultimately capacity requirements.

ACER in its "2024 Security of EU electricity supply" report[28] echoes the same principle, stating that a well-designed capacity charge should not only serve the purpose of cost recovery, but also incentivise consumers to reduce consumption during stress hours, thus reducing adequacy risks and costs (Annex A provides some additional background information on the theory of energy-only market design).

While more targeted cost recovery would not directly decarbonise the capacity supported by the CRM, it would support decarbonisation by promoting greater implicit participation from the demand side in managing

[28] ACER, *Security of EU electricity supply – 2024 Monitoring Report,* 16 December 2024

system peaks and tightness, thereby reducing the amount of capacity required and mitigating the risk of locking in new high-carbon units.

One of the features of the Target Model for market-wide Capacity Mechanisms in the Clean Industrial Deal State Aid Framework[29] is that:

> "*At least 90% of the capacity mechanism costs must be allocated to consumers based on their consumption during* ***at least 1% and at most 5% of the highest price hours*** *(or market time units) each year (or each delivery window)...*[30]" [emphasis added]

This new Target Model, introduced in June 2025, as the basis for an expedited State aid approval process for Capacity Mechanisms, therefore includes a more targeted cost recovery approach than is currently in place in the SEM. In the context of Phase 2 of this work, this will need to be considered. We are highlighting it here in the context of Phase 1 however, as we consider targeted cost recovery to be a means of supporting decarbonisation of the CRM, particularly within a timeframe in which substantial decarbonisation (i.e. deployment of CCUS or hydrogen for example) of thermal generation capacity will be challenging.

There are two key levers in the design of a targeted cost recovery mechanism – the timing of the application of the charge (i.e. time of year, day of the week, and time of day) and the distribution of the charge across consumer categories. However, for targeted cost recovery to be effective, it is essential that consumers can see and respond to the variable charge.

Despite the ongoing roll out of smart meters in Ireland, and the ongoing development of an implementation plan for roll out in Northern Ireland, as well as the planned introduction of dynamic electricity price tariffs in Ireland next year[31,32], there is currently no clear process or mechanism for domestic consumers to be made aware of (and therefore enabled to respond to) a variable capacity charge. Examples of more targeted capacity cost recovery mechanisms that are implemented elsewhere are described in Annex B.

Targeted capacity cost recovery could support decarbonisation and will need to be considered in the context of Phase 2 of this work in any case. However, we recognise that there are wider deliverability considerations with this measure due to the need for mechanisms to be in place for consumers to "see" the charge and be settled on a sufficiently granular basis.

Advantages	Disadvantages
— In line with CEEAG. — In line with the CISAF Target Model, which would support an	— Challenging to deliver within the timeframe due to interaction

[29] https://eur-lex.europa.eu/eli/C/2025/3602/oj
[30] "Price refers to either the day ahead price or a closer to real-time wholesale market or imbalance settlement price."
[31] CRU, Dynamic Electricity Price Tariffs, CRU2024121, 26th September 2024
[32] CRU, Notification to Suppliers extending timeline for introduction of Dynamic Electricity Tariffs, CRU202517, 08 April 2025

expedited State aid application for Phase 2.	with metering and the retail market.
Evaluation	
Decarbonisation impact	
Deliverability	
Does not interfere with existing CRM objectives	

7.6 Emissions Validation, Monitoring and Transparency

The Electricity Regulation[33] required ACER to develop a methodology for the calculation of CO_2 emissions in the context of the threshold limits for capacity participating in Capacity Mechanisms contained in that regulation. Pursuant to this, ACER published its Opinion in 2019[34] providing technical guidance related to the calculation, ex-ante verification, and ex-post verification (where required) of CO_2 emissions. The SEMC also published supplementary guidance on the calculation of CO_2 emissions in 2020[35].

We understand that earlier this year, the RAs undertook a review of the ACER Opinion and SEMC guidance and engaged with the TSOs, who are now advancing refinements to pre-qualification assessment, ex-ante validation, and ex-post reporting frameworks. As the SEMC moves onto a pathway to decarbonise the CRM and the Carbon emissions intensity of Capacity Market Units becomes progressively more central to the qualification process, and potentially influences the payments or contract durations that units will be awarded, the validation and monitoring of emissions will also grow in significance.

The ACER Opinion recommends ex-post validation for units that may experience significant variations in their emissions factor(s), including the following specific technology types:

- Generation units using mixed fuels;
- Waste-to-energy generation units; and
- Generation units in which CO_2 is captured and transferred.

These are unit types that may be expected to have a role to play in decarbonisation of the CRM. The scope of the ex-post validation requirement could also be expanded to include any units availing of green incentives (such as the Green Bonus or the Green Scalar), or ultimately of all units producing CO_2.

[33] Commission Regulation (EU), Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity, 14th June 2019
[34] ACER, Opinion no. 22/2019, 17th December 2019
[35] https://www.semcommittee.com/files/semcommittee/media-files/SEM-20-036%20CEP%20Technical%20Guidance%20Information%20Note.pdf

In parallel with the work currently being undertaken by the TSOs in regard to emissions monitoring and validation, the SEMC can consider publishing the resulting emissions data that is required to be made available by each unit.

This is similar to the approach now implemented in the GB Capacity Market, whereby the following additional information is to be published for CM applicants who secure an agreement:

- "*The Fossil Fuel Emissions declared by the Applicant/Capacity Provider for each Component (over 1MW), including both emissions for components and the figure for total emissions for the Capacity Market Unit (CMU);*
- *Where applicable, the Fossil Fuel Yearly Emissions declared by the Applicant/Capacity Provider for each Component (over 1MW);*
- *All fuels used to generate electricity as declared within the Fossil Fuel Emissions Declaration (FFED), and;*
- *Where applicable, whether the Combined Heat and Power (CHP), Carbon Capture Utilisation and Storage (CCUS) or Mixed Fuels formulae were applied. For mixed fuels, a list of fuels listed against individual CMU components, with a primary fuel for the CMU as a whole*."

The emissions data to be published must be independently verified. Examples of the GB Capacity Market emissions data are available online[36].

A requirement for Carbon emissions data for the SEM CRM to be published would support the development of decarbonisation policies in the future (e.g. helping to inform the setting of the CO_2 threshold as it is potentially tightened or adapted over time) as well as bringing transparency. As such, it is a supporting measure, rather than directly driving decarbonisation.

Advantages	Disadvantages
— Relatively simple to implement once the processes for monitoring and verification have been put in place.	— Additional administrative effort.
Evaluation	
Decarbonisation impact	
Deliverability	
Does not interfere with existing CRM objectives	

[36] https://emrdeliverybody.nationalenergyso.com/CM/s/cmecreport#-22

7.7 Decarbonisation Commitment from Bidders

As described in Section 5.3, participants in the Belgian Capacity Market are required to make a 'Decarbonisation Commitment'. The precise wording of this commitment is contained in Annex C. At a high level, the commitment consists of the following:

- An acknowledgement that the award of a capacity contract does not mean that units are exempt from the relevant legislation and objectives aiming to reduce emissions; and
- An undertaking to:
  1. Study the feasibility of reducing emissions by a certain date;
  2. Establish an emissions reduction plan by a certain date; and
  3. Reach zero (or negative) emissions by 2050.

We note that in SEMC's consultation and decision on ILCs, the possibility of requiring a decarbonisation commitment in the future was referenced.

While it is not apparent what the impact of the commitment to reach zero emissions will be in practice, and what the consequences would be of it not being met, particularly due to circumstances outside of the participant's control, we do consider that it would be beneficial to introduce a similar requirement for participants to develop emissions reduction plans, and to acknowledge their role in supporting the achievement of net zero targets.

Requiring the decarbonisation plan can not only oblige developers of multiyear fossil capacity to consider and develop concrete proposals for transitioning this capacity to low carbon, but can also provide useful insights to the RAs into the feasibility and maturity of a range of decarbonisation technologies in the SEM. This can support the development of regulatory policy to drive decarbonisation.

Advantages	Disadvantages
— There is precedent in the Belgian market. — Relatively simple to implement.	— Additional administrative effort required. — Uncertain at this time that the commitment to reach zero emissions would be enforceable in certain circumstances.
Evaluation	
Decarbonisation impact	
Deliverability	
Does not interfere with existing CRM objectives	

8 Recommendations

We have carried out a broad scan of options for decarbonisation of the existing CRM and screened the resulting list to remove those options that are being progressed elsewhere, or that we judge to clearly not be implementable within the timeframe of the next T-4 auction after the 2029/30 T-4 or not be compliant with State aid requirements. We have consolidated the remaining options, and applied 2 key principles in doing so:

1. that an *obligation* to decarbonise is not appropriate in the timeframe concerned; and
2. that Derating Factors should not be used to create incentives (or disincentives) for decarbonisation.

We have then evaluated the resulting shortlist of options in terms of their impact, deliverability, and alignment with the objectives of the existing CRM. Based on this assessment, we have identified two principal measures that SEMC can consider taking forward for consultation.

The first of these is the Green Bonus, which is an additional contract term of one year to be applied to ILCs and New Capacity Contracts, where the associated capacity falls below a specified emissions threshold, which should be determined through consultation with stakeholders. This option has the advantage of being relatively simple to implement, and of having precedent in the Polish CM. The measure could also be extended to include a requirement for gas units availing of the Green Bonus to be hydrogen-ready, that is, capable of combustion of a specified blend of hydrogen and natural gas – on the order of 30 vol% – without the need for further investment in the combustion equipment of the plant.

The second principal measure is the Green Scalar. This is a multiplier applied to the Capacity Payment price paid to successful units based on their Carbon emissions intensity. This option is more nuanced than the Green Bonus and permits more parameterisation and fine-tuning, but carries more risk as it is unprecedented in its implementation in CMs in the EU, and in terms of State aid approval, while also being more complex to design.

We also highlight the importance of maintaining open channels of communication with the State aid authorities in both jurisdictions to facilitate smooth passage of any changes under this workstream, whilst also preparing the ground for the next State aid application following the outcome of Phase 2 of the CRM review.

We have given consideration to a variation on the approach to ILCs, taking into account the approaches in place in other markets, such as GB and Belgium, where two durations of ILC are available. In both of these markets however, the maximum duration of New Capacity contracts is longer than in the SEM – at 15 years rather than 10 – so the span of contract duration between existing and new is wider. Our assessment is that there is little incremental decarbonisation benefit to adding further ILC durations in the SEM at this time as the routes already available for existing capacity to

refurbish and upgrade – the future investment provisions within the standalone USPC process, and the 5-year ILC – are sufficient. We also note that most respondents to the SEMC's consultation on ILCs in 2023 were in favour of longer duration contracts. Finally, the Green Bonus effectively leads to a longer ILC, though only for those units that achieve a specified level of decarbonisation.

Alongside the two alternative principal measures that we recommend considering for consultation, we have identified two "softer" measures that can help to place the SEM CRM on the path to decarbonisation.

Firstly, we understand that the TSOs are currently strengthening and refining the pre-qualification assessment, ex-ante validation, and ex-post reporting regime related to the CO_2 emissions thresholds in the Electricity Regulation and the associated ACER Opinion. These are important processes to develop and maintain alongside any measures introduced to incentivise (and potentially in future, obligate) decarbonisation of the CRM. In addition to this, SEMC can consider implementing a requirement – as has been done in the GB Capacity Market – for emissions data for capacity market units to be published on a regular basis, in order to provide transparency and to support impact assessment of policy measures, as well as the design of future measures.

Secondly, a future decarbonisation commitment can be required of new and refurbishing capacity, as is in place in the Belgian Capacity Market, along with a submission of the decarbonisation plan for each unit at qualification stage. While this prompts the question as to how the commitment might be enforced, we consider it has value nonetheless by requiring participants to actively plan for decarbonisation of their capacity (albeit in the context of uncertainty) and acknowledge their individual responsibility for contributing to meeting national, and where applicable wider, decarbonisation targets.

Finally, we believe it is important to consider not only the role of the supply side but that of the demand side also, as implicit demand response can reduce the need for new capacity and thereby help avoid lock in of new high Carbon plant. The recovery of the costs of the CRM could be targeted more effectively towards periods of peak demand, or tightest margin – an approach that is encouraged in CEEAG and by ACER, and that is required where the Target Model for market-wide Capacity Mechanisms in the Clean Industrial Deal State Aid Framework is being followed. However, we recognise that in order for the Capacity charge to be "useful" in unlocking broad implicit demand side response, the mechanisms must be in place for all consumers to "see" the charge with sufficient granularity, and notice, in order to respond effectively.

An overview of the key messages from our assessment is presented in Exhibit 14 below.

Exhibit 3: Overview of key messages.

Timeframe

Within the remaining lifetime of the existing SEM CRM:

1. Most Carbon emissions deriving from CRM supported capacity out to 2050 come from existing plants.
2. The lack of certainty on technology and infrastructure readiness makes it challenging for existing plants to commit to *full-scale* decarbonisation (e.g. H2 or CCUS).

Principal Measures

There are 2 principal decarbonisation measures that SEMC can consider:

1. The **Green Bonus** – an additional contract duration of 1 year for new and refurbishing capacity that meets a specified CO2 threshold, and for gas units, is Hydrogen-blend ready.
2. The **Green Scalar** – a multiplier on the Capacity Payment price paid to lower Carbon technologies.

Supporting Measures

There are 2 supporting measures that SEMC can consider implementing:

1. Publication of **emissions data** for Capacity Market Units on a quarterly or annual basis
2. A qualification requirement for multiyear units to make a "**Decarbonisation Commitment**", including submitting a decarbonisation plan

ILCs

We **do not recommend an additional duration ILC**.

We consider that this would add little to the investment incentives already available to existing capacity through the standalone USPC process and the 5-year ILC option.

Cost Recovery

The mechanism for recovery of the **costs of the Capacity Market should in future be targeted** to more effectively drive implicit demand response and reduce the need for new (fossil) capacity, by targeting costs at those times when demand is driving the system need for capacity.

Annex A The theory of energy-only market design

Energy-only electricity markets focus on price per unit of electricity as a signal of scarcity in supply in specific times and places, paying for deliveries of electricity or for options on such deliveries. Paying for general availability of capacity (capacity markets, capacity payments, etc.) and capacity obligations on energy suppliers (certificates etc.) would be outside this definition. Other market designs which – strictly – deviate from energy-only principles include capacity procurement or contracting by central authorities (typically the TSO) to ensure availability of capacity for specific uses[1]. Such mechanisms could be seen as market interventions that undermine the energy-only design.[2]

The key assumption of energy-only market designs is that the price structure itself will provide adequate peak capacity over the long term, based on foresight and rationality (with implicit assumptions that provision of peak capacity will resolve all other scarcities for flexibility). If there is an anticipated shortage of flexible capacity to meet a future residual peak[3], prices in these peak periods will be expected to increase (ultimately, limited only by the consumers' value of lost load), triggering an increase in forward energy (or option) prices. This will result in investment in new capacity, until the long-run marginal cost of new capacity equals the value of lost load which is avoided by the additional investment. Ultimately, the model is based on the concept that there is an economically rational level of expected unserved energy, and that it would be too costly to invest beyond this level[4], but that the market (given perfect foresight) would deliver investment up to this point.

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[1] Strategic reserves could in principle be designed to fit into energy-only principles if they are activated only as a last resort to avoid involuntary reductions of supply and the activation price is "very high".

[2] Note that even the forward procurement of balancing services or reserve products or even 'warming contracts' to commit thermal units by the TSO can have a damping effect on balancing prices and undermine energy-only price formation. In some markets, mechanisms have been implemented to mitigate this effect, through administrative price adjustments to balancing energy prices (examples include Texas, GB and Ireland).

[3] In earlier discussions on capacity adequacy, the discussion on adequacy was simply related to peak demand. Now the more precise formulation is residual peak demand, i.e. the peak of the difference between demand and supply from inflexible sources. This difference may also be negative, leading to a new set of challenges for system operation; as the system needs to deal with energy surplus as well as shortage.

[4] In those markets for which studies have been done, the typical expected 'loss of load expectation' for a balanced system is 3 hours per year: i.e. there should be (on average) three hours in peak demand by consumers cannot be met. Algebraic formulations of scarcity price formation are available.

In examining energy only market designs, the key issue is the level and distribution of 'scarcity rent' – the extent to which the market price exceeds the short run marginal cost of generation in each settlement period. There are many formulations of the theory, but the simplest is that the economic price of (day-ahead) energy in each period is a weighted average of the short run marginal cost of generation (SRMC) and the value of lost load (VOLL) when customers are cut off indiscriminately. The weighting factor between these two alternative price drivers is the likelihood that there will be a shortage of energy, the loss-of-load probability (LOLP) (which in turn implies the pricing is done in advance, typically day-ahead). Thus, price in any settlement period h is:

$$\text{Price}_h = (1 - \text{LOLP}_h) \times \text{SRMC}_h + \text{LOLP}_h \times \text{VOLL}$$

$$= \text{SRMC}_h + (\text{LOLP}_h \times (\text{VOLL} - \text{SRMC}_h))$$

The latter term [LOLP_h x (VOLL – SRMC_h)] is frequently described as the 'scarcity element' of market price, resulting in 'scarcity revenue'.

The loss of load probability is generally near to zero in most hours, but at times where there is a small margin of available capacity over demand it can increase exponentially. The scarcity element of market price is therefore highly volatile, and scarcity revenue is concentrated in a small number of hours each year. Prices should not rise above the value of lost load (if it is calculated correctly): it reflects the level at which customers would prefer to be cut off.

The economics of a sustainable power system mean that the streams of revenue cover the replacement of generation capacity when it is (economically) needed. It is uneconomic to meet all demand: instead, a system in equilibrium ends up at the point where the marginal cost of investment in new capacity (over its lifetime) balances the marginal revenue that the investment would earn (over its lifetime). Within this bigger equation, the revenue attributable to scarcity revenue will balance against the value of avoided lost load.

Compared to any reference point:

- as the value of lost load increases, then the ideal loss-of-load expectation will reduce (i.e. as we value reliability more we should pay for more of it);
- conversely, as the (net) cost of building or maintaining capacity increases then the (ideal) loss-of-load expectation will increase (i.e. as reliability becomes more costly, we should get less of it).

The (net) cost of capacity is not just technology driven, as it depends on nature of capacity which is required and on the other sources of income for that capacity. In a traditional system dominated by thermal power stations, most new entry generation has been able to run for many thousands of hours each year, displacing other capacity and earning infra-marginal rent for many of those hours. In these circumstances, the **net** cost of capacity and the reliance on scarcity pricing is relatively low.

As electricity systems become increasingly dominated by wind, the required capacity margin increases, and the number of hours of operation and the infra-marginal rent accessible by even the most efficiency thermal plants is reduced. In such systems, the 'best new entrant' with the lowest (net) cost of capacity eventually shifts from being a CCGT to a peaking generator with far lower operating hours; it could be said that wind increases the (net) cost of conventional capacity. It means that the same capital cost needs to be recovered from far fewer hours by much higher prices in the energy markets.

The economics of building new peaking capacity strains energy-only markets: unlike CCGTs, these plants are very heavily reliant on scarcity revenue from a just a few hours per year[6].

As the (net) cost per MW of capacity increases, it becomes more economic to unpick the meaning of 'lost load' (which by its nature is indiscriminate) and instead to access demand response at different price levels. Thus, as the share of wind generation increases, the importance of demand response increases. Demand response may be considered to be selective rather than indiscriminate load reduction.

[6] For example, as part of the capacity mechanism calculations in SEM, the cost of a 'Best New Entrant' is calculated. Most recently, the best entrant has been an open cycle gas turbine.

Annex B Examples of targeted capacity cost recovery

Country	Approach
France	— EDF in France offer a "tempo" tariff, which applies significantly higher rates during a limited number of "red days" – these being the 22 days of highest system stress. — A 'red day' rate exceeds €200 per MWh and applies to consumption over 16 hours (totalling 352 hours annually). — There are 300 'blue days' during which the tariff is low, and 43 'white days' during which the tariff is slightly higher than on the blue days. — From 11 o'clock on a given day, consumers can check the 'colour' of the following day to understand whether they need to plan to reduce their consumption or not.
Italy	— A 'short-peak' charge is applied, which is 37 times higher than the off-peak charge. — It applies to consumption during the 500 hours in a year with the lowest surplus of supply over demand. — Importantly, consumers in Italy are informed in advance about peak hours for the upcoming year.

Annex C Belgian CM Commitment to Carbon Neutrality

The below excerpt is taken from the Functioning Rules of the Belgian CRM[37], as an example of what a decarbonisation commitment might look like for the SEM:

"116. *The CRM Candidate that wishes to obtain prequalification for a CMU that comprises a fossil fuel-fired electricity production unit having the possibility to sign a Capacity Contract relating to more than one Delivery Period acknowledges that obtaining such a Capacity Contract does not exempt it either from the legislation or current and future objectives established by the European Union and/or Belgium aiming to reduce greenhouse gas emissions.*

In addition, it agrees, in the event of obtaining such a Capacity Contract to contribute to the work to prepare policies to achieve said objectives. To that end it appends to its Prequalification File a written declaration in which it undertakes, in the event of one of its Bids being selected in the Auction:

- *to study the technical and economic feasibility of reducing greenhouse gas emissions, in accordance with relevant European and Belgian legislation and objectives, for the CMU in question by no later than 31 December 2027;*
- *to establish, by 31 December 2028, a greenhouse gas emissions reduction plan indicating how the CMU in question will contribute to the transition to carbon neutrality in 2050, with interim objectives for the years 2030, 2035 and 2045. The different CRM Actors concerned by the establishment of an emission reduction plan can decide to create this plan jointly; and*
- *to reach, for the CMU concerned, zero or negative emissions by 2050 at the latest.*

Compliance with the undertakings set out above is verified by the Federal Public Service Economy."

[37] 20250515_CRM_FunctioningRules_Err_EN (1).pdf

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We don’t care much about making history.

We care about making future.